Life and Health Series.

FOODS

THEIR COMPOSITION AND FUNCTIONS

By
W. H. RILEY,
M.D.

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*Foods: Their Composition and Functions.

THIS is a subject which most people who come to the Sanitarium are particularly interested in, and one in which I think every one should be interested. The farmer pays a good deal of attention to the feeding of his stock. It is the only way he can get good results. But the human family pays very little attention to its food as compared with the attention paid to the food of the lower animals. There is not nearly as much attention given to the development of healthy human subjects as there is to the development of healthy horses, sheep, and other domestic animals.

It is Highly Proper

for us to give some attention to this subject, and here at the Sanitarium our work is educational; we endeavour to teach people how to live healthfully so that they will keep well after they have left us. Most people who are at all interested in the subject of foods are particularly interested in this subject, as it relates to the particular foods that they should use.

***An Address delivered at the Battle Creek Sanitarium, January, 1911, and reprinted from "Battle Creek Idea," February 17th, 1911.**

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That, of course, is very important, and it is primarily proper to study the matter in this way. But to-night I am not going to deal with that side of the subject. I am going, rather, to deal with what I consider some fundamental principles. And if we understand some of the fundamental principles with reference to food, we shall be better able to select our foods, and to understand more intelligently the foods that are best suited to particular conditions of the body.

So, at the outset, I want to give you

A Definition of Food.

A food is any substance that contains material and energy that the body can utilize. Or, we may say that a food is any substance that contains material that is used in the body for the growth of, or for the repair of, tissue, or for furnishing energy to the body. And I wish to emphasize this fact, that food contains two things that are useful to the body, one of which is material and the other is energy. I hope you will keep that in mind as we are discussing this subject; these are the only things there are in a food substance that the body utilizes. There are other useful qualities that belong to good food, such as taste, appearance, savor, etc., because a food should be attractive and palatable; but these are subordinate qualities rather than essential elements.

A material substance in order to be a food must be of a peculiar kind. For instance, I have here on the table a piece of coal, and I have here a piece of bread. They are both material, and both contain a large proportion of energy. One is a food, and the other is not a food. And one reason at least why this piece of coal

is not a food is because the material in it is not put up in the right way for a food; whereas the material in this piece of bread is composed in such a way that the body can use it. That is the principal reason why the body cannot use the material in the coal, and the body can make use of the material in the bread. Now, if we analyze these two substances, we find that the coal is made up largely of carbon, and we find in the bread quite a large amount of carbon, but not so much as there is in the coal. They both contain carbon, but the carbon in the bread is put in in a different way from that of the coal. So you see, it is the construction, the arrangement, of the material in this bread that makes it a food. Of course, there are chemical elements in each that are not in the other, and yet we have carbon in the bread the same as in the coal.

With Reference to Energy.

The same thing is true with reference to energy. There is lots of energy in the world that the body cannot utilize. Sunlight is a very essential element to health and life, it is true, but the body does not absorb the energy that is in the sunlight directly. That property belongs to the plants. Plants have the ability to absorb and store up the energy, but animals cannot do that. So the animal cannot make use of the sunlight as such directly. But as the sunlight passes through a plant the plant will store the sunlight up in it and make substances such as we have in a food, and thus the body can take that sunlight and use it.

Sunlight acts upon the animal as a normal, physiological stimulant. As such it is very essential. We cannot live without sunlight for any great length of time,

but that energy is not absorbed by the animal any more than the energy that a man uses in whipping his horses is absorbed by the horses. The whipping simply is used to get more energy out of the horses. And that is the way that sunlight acts upon our bodies—as a stimulant, acting through the nerves, the skin, and different parts of our bodies, stimulating the machinery of the body; but that energy is not absorbed by the body in any way. And it is the same with a great many other forms of energy—electrical and mechanical energy of various sorts—the body cannot take them into itself and use them as such. Those energies may be utilized in some other way by the body. The only way that energy gets into the body is by taking food. It comes from the food that we eat.

How Food Material is Utilized.

The material that is in the food is used in the body in many different ways. The young growing child uses the material for building bone and muscle and blood and brain. After a man gets his growth, he does not need food in that sort of a way, because he has reached his growth. But he does need food to repair the waste. This body of ours is a sort of machine. And I speak very respectfully when I speak of the body, because there is nothing in the world that is entitled to more respect than the human body. But yet we may properly compare our body to a machine. Put energy into the machine, and the energy comes out in some other form. Put energy into a dynamo, and it comes out in the form of electricity. We put energy into our bodies, and it may come out in many different forms.

As we go about our duties through the day, our body

is wearing out. There is a wear and tear every day, and that wear must be repaired; and food contains certain materials that will build up that which is worn out. The amount of food necessary to repair the waste of an adult is not so great as the amount required to build the muscle, the brain, and the blood during the growing process, so that the child while growing requires more of certain food elements during this period than he does later in life when he is not growing.

The Energy of the Body.

The energy we take into our bodies in the food is used in a great many different ways. A large portion of it is used in keeping the body warm. The temperature of the body is the same in the winter as in the summer; though the temperature of the atmosphere is very much lower in the winter than in the summer, yet the body temperature remains the same. I think you can all readily understand that when the temperature may be twenty degrees at one time, and another time perhaps eighty degrees and the body temperature remains the same, more heat must be made when the temperature is lower in order to maintain the body temperature than at another time when the atmosphere is warmer. And the body adjusts itself to conditions; more heat is made in the body in the winter than in the summer.

A large part of the energy that comes from food is used for furnishing heat to the body. There are some people who have lost to a great extent the ability to make heat. We are not apt to think of our bodies as heat-producing machines. We think about our stomach, our liver, our heart, and nerves, but our attention is seldom directed to the function of heat producing.

When our feet or our hands get cold, we attribute that to poor circulation ; and that may be partly the cause, but very often another cause is the fact that the heat-producing function of the body is running at a low speed. I have seen many people in my experience in that case.

Heat is Produced

by chemical changes going on in the body. There are some people in whom those chemical changes act slowly, and consequently all the other functions of the body are interfered with and act in about the same way, because those chemical changes, which are the basis of all the other functions of the body, do not go on promptly. So I want to emphasize that the heat-producing function of the body is a very important one.

One of the best things in the world to stimulate the heat-producing function of the body is the use of cold, short baths, or going out in the cold air will do the same thing. You take a short cold bath in the morning, and when the cold water is applied to the body a certain amount of heat is abstracted and carried off from the body by the cold water, and then the body gets to work immediately and makes more heat, and thus the heat-producing function is stimulated and more heat is made in the body. People whose heat-producing power is reduced take cold easily. A strong, healthy young man does not take cold as a rule, unless he is very severely exposed.

Another good preventive against taking cold is out-of-door exercise. A great many people in the North go South in order to get rid of the cold winters. I am certain a great many people make a mistake in doing that. There may be some who are very feeble and

whose resistance is very low, for whom it may be proper to get away from the cold air of the North ; but generally I am afraid it is a mistake, because one of the best tonics in the world is the cold air, such as we have out of doors in winter. Cold air acts on the body the same as cold water. It is not the water that is of any value. It is the heat and the cold in the water. Water is simply a medium in conveying the heat and cold ; and it is the heat and the cold that do the good. If one takes a cold bath or exposes himself to cold air too long, instead of its being a tonic it will act as a depressent. The only reason why it acts as a tonic is because it arouses the latent forces in the body.

Besides the energy that we take into our bodies in the food that is used for keeping the body warm, is the energy used in muscular work. And the energy that we use in muscular effort comes from that food that we eat. There is no other way in which we can obtain energy. We do not make energy ; nobody can make energy. Our body is a sort of apparatus for taking the energy that is in the food and transforming it into many other forms,—into heat, into muscular work, into mental work, and energy for the use of the various glands of the body in performing their work. This energy obtained from food is used in all the bodily activities, voluntary and involuntary, and even for doing our mental work. In mental work we are expending energy in a certain amount ; it is a very subtle form of energy, and yet we spend energy in thinking, and that energy comes from the food alone.

Now let us notice

The Origin of the Material

that is in the food. The material in the food comes

from the earth, the air, and water. This material is taken up by the plants in simple compounds. For instance, a plant takes carbon-dioxide and water, and out of that it will make starch. Two parts of hydrogen and one part of oxygen united chemically form water. And one part of carbon and two parts of oxygen united chemically form carbon-dioxide or carbonic acid gas.

The plant takes up carbonic acid gas and water and other simple compounds like these, and out of these the plant will form foods. Starch contains six parts of carbon, ten parts of hydrogen and five parts of oxygen. The plant takes these simple elements out of the earth, and we get them in the form of food. After they pass through the plant and the plant forms them into starch, then the animal gets the energy out of the starch that the plant makes.

The plant takes ammonium compounds and other simple compounds, and puts them together into a chemical compound that we call a food. A plant is the only medium in the world that can make a food.

Animals do Not Make Food.

That may seem like an extravagant statement, but it is correct. Of course some will say that the animal eats hay and grass and the flesh of the animal is food. The animal that eats that food has a digestive apparatus arranged in such a way that he can digest hay and grass, but the human subject cannot. But in eating the animal, man appropriates the food eaten by the animal. There are different kinds of plants, and the plants take substances and make foods out of them.

Plants are food producers; animals are food consumers. Some plants produce food especially for human

stomachs, and some produce foods for the stomachs of grazing animals. It seems to me that this point would have a very important bearing in answering the question, "What is the natural food for man?" The animal does not make food. Plants are the only things in the world that make food. A plant will take materials that are not foods for the animal and make food out of them.

Then, the material in

Our Food Comes from the Earth,

the air, and water, and before these become foods they pass through the chemical laboratory of the plant, and the plant takes these substances which are not foods and makes them into substances which are foods. Animals cannot live without plants. One animal might eat another, and that would only result in the destruction of all animals.

Of course you understand there are some substances such as common salt, and what we might call inorganic foods, that are of mineral origin, and water. Their food value is very little indeed, and they do not have a very important bearing on digestion. And yet they are food substances, perhaps, and they may be used without passing through the plants, but they do not interfere with the principle as stated.

What is the Origin of the Energy in the Food?

All of the energy that is in the food comes from the sunlight. And the energy that we are expending to-day in doing our daily duties, at one time existed in the form of sunbeams, and that energy was gathered and stored up by the plant. And the energy that we take into the

body in the form of food comes from the sunlight, passes through the plant, and then we take it into our bodies in the form of food. And there is a very definite and close relation existing between the amount of energy that we expend and the amount of energy that we take in. If we compute the number of heat units that we take into our bodies, and that are consumed, we can figure out the amount of energy that leaves our bodies. There is no more that leaves our body than we can take in; one equals the other. The energy may remain in the body temporarily, yet it all eventually comes out.

There is some energy in carbon-dioxide, and there is a great deal of energy in water, but the body cannot get the energy out of the water. Water enters the body as water and leaves the body as water, consequently does not leave any energy in the body in passing through it. In order to give up energy to the body, a substance must be changed chemically. Water is not changed at all; therefore, does not give up any energy. And so it is with carbon-dioxide; it has some energy, but the body cannot appropriate it, and so cannot use it.

A Food is any Substance.

that contains material and energy that the body can utilize. The body cannot use the energy from the sun directly. It must come through the plant before the body can use it.

In order to have our definition complete, we must add that a food must not contain any substance that is harmful to the body. There has been some discussion in recent years in scientific circles with reference to whether alcohol is a food or not. It is true that a small amount of alcohol is oxidised or burned up in the body.

But that does not prove that it is a food. It is not a food.

Food is a chemical compound; that is, it takes two or more chemical elements to make a food. If you have a food with two chemical elements, when you divide them, that substance ceases to be a food, so a food substance is the simplest and most elementary form in which it can exist as a food. If reduced to simpler forms it ceases to be food.

We have six different food elements. You may dine with a king and have a very elaborate bill of fare; it may be fixed up in many different ways, but you cannot get into the bill of fare more than six different elements. On the other hand, we may eat our meal by the wayside with the labouring man, and if he has these six food elements in his meal in the right proportion, our bodies are furnished with nourishment just as well as though we had eaten with the king. In other words, the six food elements are the things that nourish the body; no more, no less; we cannot add anything to them that is essential.

Carbohydrates.

First of all we have what are called carbohydrates. These contain carbon, hydrogen, and oxygen. Carbohydrate is a chemical word; it means the hydrate of carbon; and a hydrate is a substance that contains hydrogen and oxygen in the same proportions that they are present in water. And a carbohydrate is a substance that contains hydrogen and oxygen in the same proportion that they are present in water, and in addition contains carbon. Carbohydrates are furnished to us by all the cereals. All breads and all the different foods

made from grains contain carbohydrates. The vegetables also furnish a large amount of carbohydrates. And then in the form of sugar we have another carbohydrate.

Carbohydrates are found in several forms. First, we have cellulose, represented by the bran of the wheat, and by the fibre in fruit and in vegetables—a sort of very fine wood. Cellulose cannot be digested by the human digestive apparatus. The lower animals, particularly the herbivora, can digest cellulose; but the human digestive apparatus cannot digest cellulose to any great extent. Our bran biscuit is used for a medicinal purpose, for relieving constipation. If we could digest the bran, the biscuits would lose their therapeutical effect; they would not relieve the constipation because the food would be digested and absorbed, and the reason it relieves constipation is because the bran is not digested but furnishes the bulk which aids in moving the bowels.

There are starches; and there are a great many different kinds of starch, such as corn starch, wheat starch, potato starch, etc. The chemical formula for these starches is $C_6H_{10}O_5$. Take the several sorts of starch and put them under a miscroscope and you will find that the granules have different outlines for different kinds of starch. These little granules of starch are something like a little box, and inside of this box is the starch granule, and the box is cellulose. We cook starch to break this box, dissolve the cellulose covering and allow the starch granules to escape. The human digestive apparatus cannot digest raw starch.

Sugar is produced in the cane and in many other plants. There are different kinds of sugar, cane sugar,

grape sugar, levulose or fruit sugar, and the sugar of milk. These are the principal sugars. Cane sugar is used as a food more than any other. But cane sugar is not the best kind of food. Taken in large quantities it irritates the mucous membrane of the stomach. One who has an excess of acid in his stomach should not eat much cane sugar, because it irritates the lining of the stomach and tends to increase the secretion of acid; it also increases the secretion of mucus in the stomach, and if one has hyperacidity or hyperchlorhydria, he should certainly

Restrict the Use of Cane Sugar.

Grape sugar is the sugar of the grape, which has a different chemical formula than cane sugar, and it is more wholesome. The sugar of fruit, levulose, is a very wholesome sugar, and it is found in the fruit principally. Here at the Sanitarium we have what we call malt honey, or meltose. It is the same kind of sugar that we make in our mouths when we eat starch. The saliva converts the starch and dextrin in food into sugar, and that sugar is called maltose. At the Sanitarium we have to deal with a lot of people who cannot digest starch well, and that is the reason that we manufacture this malt honey.

Fats and Oils are Foods.

Generally speaking, fats are produced in the animal kingdom, and oils in the vegetable kingdom. There are three principal kinds of fats: the hard fat, called stearin; soft fats, called olein and palmitin. Oils are found largely in the vegetable kingdom, such as olive oil, and nut oils; these contain the same chemical elements as the carbohydrates, but they are composed

in a different way. The chemical formula for them is rather complex.

There is more energy in the fats and oils than in the carbohydrates, but the fats and oils do not lend themselves so readily to the use of the body ; the body cannot get the energy out of the fats and oils so readily as out of the carbohydrates, and so perhaps they are not quite as good a class of food ; and yet in some respects they are desirable. And I should mention butter and cream, which are the most common forms of fats used as foods.

Fats and oils have, in addition to their food value to the body, other very useful qualities. If one has a high degree of acidity, he should eat a large amount of fats and oils, while a person with an insufficient degree of acidity should avoid these elements. Fats and oils have a laxative effect. And they are of some importance in stimulating nutrition. Particularly in tuberculosis fats and oils seem to have a very stimulating effect upon nutrition.

Another Food Element is Acid.

These are principally fruit acids, such as the tartaric acid of the grape, malic acid in the apple, citric acid in the strawberry, and the lemon, oranges, and other citrus fruits. Then we have the lactic acid in milk. These are the principal acids. These acids are very important, however. Their value has not been properly appreciated. In addition to their food value, these acid fruits also have a certain medicinal value. They are very good when one has too little acid in the stomach. One can then take the acid fruits freely, not because the acid in the fruit in any way takes the place of the acid in the stomach so far as digestion is concerned, but

because the acid in the fruit disinfects the stomach and prevents diseases from coming in. Germs will not grow in an acid medium, and this is the value of the fruit in those cases.

Then we have salts as a food element. We find phosphate of lime, carbonate of lime, and a great many other salts. Some of the French physicians have found out quite recently that the potato is a very valuable food in the treatment of diabetes, on account of its possessing potassium salts, and we use it here for that purpose. Certain salts enter into the structure of the bones. A child has rickets because he has not had the proper salts in his food to nourish his bones, and they became deformed in that way. Scurvy is produced from the lack of these salts.

The value of raw food is at least partly due to the fact that they contain these salts, and we have here every meal some raw food on the tables, like celery, lettuce, radishes, or something of that kind that contains these salts.

Next we have water. Water does not furnish energy to the body. It simply furnishes material. Four-fifths of our brain is composed of water, and every tissue of the body abounds with water. The best kind of water to drink is distilled water.

I have gone over this subject very hastily, and have not discussed the proteins, but have given you the basic facts in reference to the subject of foods.

The Protein Content of Foods.

SO much is being said nowadays about proteins, carbohydrates and fats as components of foodstuffs that it may be of interest to the readers to have at hand for reference a concise summary of the characteristics of various common foodstuffs as regards the protein element. Here is a summary based upon the tables of Gautier, the latest and best authority on foods :

Proteins are found in various classes of foods in the following proportions :

25 per cent. and upwards : peas, beans, lentils, pine nuts, pea-nuts, almonds.

13 to 23 per cent. : beef, mutton, birds, fish, and some nuts.

8 to 13 per cent. : bread, flour, oatmeal, cornmeal, toasted wheat, rice and corn flakes, and other breakfast cereals.

2 to 7 per cent. : rice, cow's milk, dried fruits.

1.5 to 3 per cent. : mother's milk, potatoes, cabbage, spinach and greens.

Less than 1 per cent. : watery fruits, honey, sugar, corn starch and tapioca.

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